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ALGEBRA.

Conducted by J. M. COLAW, Monterey, Va. All contributions to this department should be sent to him.

24. **Proposed by ARTEMAS MARTIN, LL. D., U. S. Coast and Geodetic Survey Office, Washington, D. C.**

Find x and y from the equations,

$$x^2+2xy^2-2xy=4y^3,$$
$$y^4+2x^3y^2-2xy^2=4x^4.$$

I. Solution by J. K. ELLWOOD, M. A., Principal of Colfax School, Pittsburg, Pennsylvania: and B. F. BURLESON, Oneida Castle, New York.

The first equation may be written $x^2+2x(y^2-y)=4y^3$.

Completing squares, $x^2+2x(y^2-y)+(y^2-y)^2=4y^3+(y^2-y)^2=(y^2+y)^2$. Whence $x+(y^2-y)=\pm(y^2+y)$, and $x=2y$ or $-2y^2$....(1).

The second equation may be written $y^4+2y^2(x^3-x)=4x^4$. Completing squares, $y^4+2y^2(x^3-x)+(x^3-x)^2=4x^4+(x^3-x)^2=(x^3-x)^2$,

whence $y^2=2x$ or $-2x^3$.....(2).

Equating *positive* values of x from (1) and (2), we find $y=4$. Then $x=8$.

Solved with similar results by *J. H. DRUMMOND, P. S. BERG and the PROPOSER.*

II. Solution by M. A. GRUBER, A. M, War Department, Washington, D.C., D. G. DORRANCE, Jr., Camden, New Jersey, and J. A. TIMMONS, A M., Professor of Mathematics in St. Mary's College, St. Mary's, Kentucky.

Equation (2) becomes $y^4+2xy^2(x^2-1)=4x^4$.

Completing square and reducing, we get $y^2=2x$ or $-2x^3$;

whence $x=\frac{y^2}{2}$ or $\left(-\frac{y^2}{2}\right)^{\frac{1}{3}}$.

Equating these values of x with those found from Eq. (1), we have $2y=\frac{y^2}{2}$, $-2y^2=\left(-\frac{y^2}{2}\right)^{\frac{1}{3}}$, and $2y=\left(-\frac{y^2}{2}\right)^{\frac{1}{3}}$;

whence $y=0,\ 4, -\frac{1}{16}, \pm\frac{1}{2}$, and $x=0,\ 8, -\frac{1}{8}, -\frac{1}{2}$.

Solved with same results by *OTTO GECKELER. F. P. MATZ, COOPER D. SCHMITT, and G.B.M.ZERR.*

III. Solution by C. E. WHITE, Trafalgar, Indiana; C. W. M. BLACK, A. M., Department of Mathematics, Wilmington Conference Academy, Dover, Delaware; and JOHN B. FAUGHT, Bloomington, Indiana.

By factoring the equations, they may be written

$$(x+2y^2)(x-2y)=0, \text{ and } (y^2+2x^3)(y^2-2x)=0.$$

$$\text{Whence } \begin{cases} x+2y^2=0\ldots.(1) \\ x-2y=0\ldots..(2) \end{cases}$$
$$\begin{cases} y^2+2x^3=0\ldots.(3) \\ y^2-2x=0\ldots..(4). \end{cases}$$

The values that will satisfy (1) and (3) are easily found to be $x=0,\ \pm\frac{1}{2}$ and $y=0,\ \pm\frac{1}{2}\sqrt{(-1)},\ \pm\frac{1}{2}$; (1) and (4), $x=0$, and $y=0$; (2) and (3), $x=0, -\frac{1}{8}$, and $y=0, -\frac{1}{16}$; (2) and (4), $x=0,\ 8$, and $y=0,\ 4$.

$\therefore\quad x=0,\ 8, -\frac{1}{8}, \pm\frac{1}{2}$, and $y=0,\ 4,\ -\frac{1}{16}, \pm\frac{1}{2}, \pm\frac{1}{2}\sqrt{(-1)}$.

Solved with like results by *J. F. W. SCHEFFER.* Also solved by *J. A. CALDERHEAD, H. W. DRAUGHON, A. L. FOOTE, J H. GROVES, and H. C. WHITAKER.*

28. Proposed by P. C. CULLEN, Meade, Nebraska.

A man and a boy get n dollars for digging potatoes, the man can dig them as fast as the boy can pull the vines, but the man can pull vines m times as fast as the boy can dig them. Divide the money.

I. Solution by A. L. FOOTE. C. E., Merrick, New York; P. H. PHILBRICK, C E., Lake Charles, Louisiana; and J. A. CALDERHEAD, B. Sc., Limaville, Ohio.

Let x be the cost of all the digging,and y the cost of pulling the vines; then $x+y=n$....(1). Now by the conditions the man can perform the effect x, while the boy performs the effect y. Also the man can do my, while the boy does x. Therefore we have $x : my :: y : x$, or $x^2=my^2$ ...(2). $\therefore\quad x=y\sqrt{(m)}$....(3). Substituting in (1) we have

$$y=\frac{n}{1+\sqrt{(m)}},\text{ and } x=\frac{n\sqrt{(m)}}{1+\sqrt{(m)}}.$$

II. Solution by J. H. DRUMMOND, LL. D , Portland, Maine.

The problem is indeterminate unless we assume the man's rate of digging and of pulling vines bears the same ratio to each other as the boys. Let x= the man's time for pulling vines and px, his time of digging; and y= boy's time for pulling vines and py his time of digging. Then $\frac{1}{x}$ and $\frac{1}{px}$ = man's rate of digging and pulling vines, respectively, and $\frac{1}{y}$ and $\frac{1}{py}$, boy's rate.

Then $\frac{1}{px}=\frac{1}{y}$, and $\frac{1}{x}=\frac{m}{py}$. Hence $y=px$ and $y=\frac{mx}{p}=px$. Hence $p^2=m$, and $p=\sqrt{m}$

$\therefore\ y=x\sqrt{m}$. $\frac{1}{x}+\frac{1}{px}$=man's work in same time boy works, $\frac{1}{y}+\frac{1}{py}$, or $\frac{1}{x\sqrt{m}}+\frac{1}{mx}$. Then $\frac{1}{x}+\frac{1}{x\sqrt{m}}+\frac{1}{x\sqrt{m}}+\frac{1}{mx}$=what both would do in same time, or $\frac{m+2\sqrt{m}+1}{mx}$.

Then $n\left(\frac{m+\sqrt{m}}{mx}\right)\div\frac{m+2\sqrt{m}+1}{mx}$=man's part$=\frac{n\sqrt{m}}{1+\sqrt{m}}$, and

$n\left(\frac{\sqrt{m}+1}{mx}\right)\div\frac{(1+\sqrt{m})^2}{mx}$=boy's part$=\frac{n}{1+\sqrt{m}}$.

III. Solution by J. H. GROVE, Howard College, Brownwood, Texas.

Let d= the amount of work digging a certain distance, and p= the